

Petrochemicals and Economic Development: Issues and Challenges

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Abstract

The theory holds that crude oil was formed as a result of the bacterial decomposition, under pressure of animal and plant remains once living in the sea, which use buried in certain porous strata of the earth's crust. Both natural gas and crude oil accumulate in porous formations capped by dome-shaped impervious lampas of rock. The presence of oil in rock formations under conditions of temperature, pressure, and atmospheric composition explains why petroleum can be found in the desert. Petroleum is a dark viscous liquid which consists of a highly complex mixture, and its main constituents being hydrocarbon. Hydrocarbon is a compound containing hydrogen and carbon only as its name implies. Parallel to the stimulation of other industries the widespread application of petrochemicals effectively creates a lot of jobs in some specific industries. The sectors benefiting most for the indirect generation of employment are agriculture, textile, plastics, construction, automobile, health and consumer goods industries. The international labour organization (ILO) draws the conclusion that the development of petrochemicals leads to a general growth of all the sectors of the economy. Therefore, for Nigeria to achieve the vision 2020:20 it is a must to develop and enhance the petrochemical processing plants and explore more petroleum products especially in the off shore to supplement the existing ones.

1. Petrochemicals and Economic Development

Petrochemicals are generally products derived from crude oil and Natural Gas.

Petroleum (Crude Oil) is a dark viscous liquid which consists of a highly complex mixture, and its main constituents being hydrocarbon. Hydrocarbon is compound containing only hydrogen and carbon as the name implies. It can be represented by the chemical formula (C_xH_y) where X and Y are whole numbers (Ewelukwa & Ekpeh 1993). On a structural basis, hydrocarbon can be divided into 2 main classes.

- a. Aliphatic (Straight Chain, Branched, open or closed)
- b. Aromatic (cyclic or ringed).

These hydrocarbons include alkanes, cycloalkanes, and aromatic hydrocarbons. Generally, petroleum (crude oil) differs in composition from field to field. For example Nigerian petroleum is low in sulphur which makes it less pollution.

Petroleum when refined provides fuel for automobile (motor cars) and internal combustion engines and is also used in the synthesis of organic chemicals.

1.1 The origin of crude oil

Crude oil is the name given to naturally occurring petroleum. There are 2 types of theory on the formulation of petroleum.

- The organic matter theory and

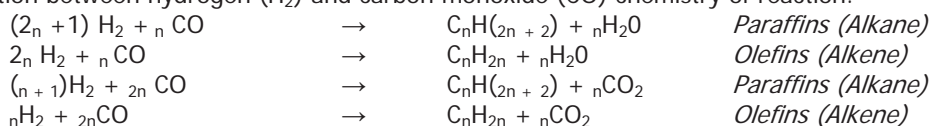
- The atmospheric chemical reaction theory.

1.2 The Organic Matter Theory

The theory holds that crude oil was formed as a result of the bacterial decomposition, under pressure of animal and plant remains once living in the sea, which were buried in certain *porous strata* of the earth's crust. Both natural gas and crude oil accumulate in porous formations capped by dome-shaped impervious layers of rocks. The presence of oil in rock formations under conditions of temperature, pressure and atmospheric composition explains why petroleum can be found in the desert (offshore).

1.3 Atmospheric Chemical Reaction Theory

The theory suggests that the formulation of crude oil is very much older than the existence of life on the earth and that it was formed through chemical reactions when the earth was still hot by reaction between hydrogen (H₂) and carbon monoxide (CO) chemistry of reaction.



As cooling of the earth proceeded condensation occurred and there began a "petroleum rain" which lasted for perhaps 2 billion years (Ekpeh, 2006).

1.4 Refining of petroleum and uses of its fractions

Petroleum Refining:

The preparation of useful products from crude oil or petroleum is known as refining.

1.5 Fractional Distillation of Petroleum

Fractional distillation is the process of separating two or more volatile, miscible liquids with different boiling points. Petroleum as a complex mixture of hydrocarbons can therefore be separated into its components by fractional distillation using a fractionating column.

Petroleum is heated in a furnace to about 400°C and then rapidly pumped into fractionating tower. The vapour rises up the tower and is cooled. When condensation begins, part of the condensed liquid is then pumped back to the top of the tower.

1.6 Petroleum fractions

| Boiling Point (°C) | Product | Approx. Composition | Uses |
|--------------------|---|-----------------------------------|--|
| Below 20 | Gaseous compounds: natural gas, methane, ethane propane, butane | C ₁ – C ₄ | Fuel, raw material for chemical industries. |
| 20 – 90 | Light petroleum | C ₅ – C ₇ | Solvents |
| 90 – 120 | Ligroin (High BP Petroleum ether) | C ₇ – C ₈ | Solvents |
| 100 – 120 | Petrol (Gasoline) | C ₅ – C ₁₀ | Fuel for Automobile |
| 200 – 300 | Paraffin (kerosene) | C ₁₂ – C ₁₈ | Fuel for automobiles, lamp, stove and jet aircraft |
| 300 – 400 | Diesel oil | C ₁₅ – C ₂₅ | Fuel (Locomotives) |
| 300 – 400 | Lubricating oil | C ₂₀ – C ₂₄ | Lubricants, waxes, Vaseline |
| 400 Above | Paraffin wax | C ₂₁ – C ₃₀ | Various uses (candles) |
| Solid residue | Asphalt (Bitumen) | C ₄₀ & above | For road construction and for making roofing materials |

2. The Petrochemicals

Petrochemicals are generally products derived from crude oil and natural gas. Petrochemical materials are used in the production of industrial consumer goods. Like plastics, synthetic fibers synthetic detergents, synthetic rubber and solvents. In addition to the above, the petrochemical industry is the source of base materials for many other chemical products like paints, dyes, adhesives, agrochemicals, pharmaceuticals, and other useful chemicals.

2.1 Petrochemicals and the Economy

The role played by petrochemicals in the other major sectors of the economy such as:

- i. Agriculture
- ii. Apparel (Textile)
- iii. Automobile
- iv. Building And Construction
- v. Pharmaceuticals (Health)

2.1.1 Agriculture



Ammonia on which the productions of nitrogenous fertilizers are entirely based is synthesized from petrochemical products such as hydrogen. *Pesticides, fungicides (Bordeaux mixture)* and herbicides are petrochemical-based products.

Petrochemical products such as *polyvinyl chloride (PVC)* and High density *polyethylene (HDPE)* are used to produce irrigation pipes, silage shelter containers and rigid sheets.

Preservatives (such as *Benzoic Acid*) used to preserve food and beverages in canning industries are synthesized from petrochemicals.

Plastics film²³ for green-house covering, mulching and water conservation are made from petrochemical products such as low density *polythene (LDPE)*. Insecticides, Fungicides and herbicides used to destroy pests are all chlorinated derivatives of petrochemical products.

Finally, distribution of food materials in commercial quantities is not possible without large scale packaging with plastics which is derived from petrochemicals.

It is thus evident that no meaningful agricultural revolution can take place without massive inputs from petrochemical sector. Consequently the only alternative to the domestic production of these products is to resort to import; with the consequent large drain on the nation's foreign exchange.

2.1.2 Apparel: Textile



Clothing is fiber and textile material worn on the body. The wearing of clothing is mostly restricted to man and is a feature of nearly all human societies. The amount and type of clothing worn depends on physical, social and geographic considerations, including sex (some clothing-types can be gender-specific: since about the First World War in Anglo-American societies blue has been associated with boys and pink with girls).

Physically, clothing serves many purposes: it can serve as protection from the elements, and can enhance safety during hazardous activities such as hiking and cooking. It protects the wearer from rough surfaces, rash-causing plants, insect bites, splinters, thorns and prickles by providing a barrier between the skin and the environment. Clothes can insulate against cold or hot conditions. Further, they can provide a hygienic barrier, keeping infectious and toxic materials away from the body. Clothing also provides protection from harmful UV radiation.

In Nigeria, textile manufacture from natural fibres like cotton is heavily blended with synthetic fibres without which it will become archaic and obsolete.

The modern man has acquired an uncompromised demand for quality products. Thus, in this country, has resulted to exponential growth in the demand for imported foreign made textile goods, forcing the government almost in desperation to resort to absolute banning.

- ➔ Shoe soles and battler cloths are made from PVC (*Polyvinyl Chloride*) and adhesives used in this industry are all petrochemical base.
- ➔ In the textile industry, *Monoethylene Glycol* (MEG) and *Taraphthalic Acid* (TPA) are bases for *polyester* fibres manufacture. Nylon fabrics are very common petrochemical synthetic fibres. Linear *alkyl benzene* (LAB) and other chemicals are used for the manufacture of soaps and detergents. Dry cleaning chemicals are petrochemical products. Petrochemicals also supply thousands of synthetic dyes in an unlimited number of shades for textiles and essential auxiliaries for processing textile materials.

2.1.3 Automobile Industry



The Japanese automotive industry is one of the most prominent and largest industries in the world. Japan has been in the top three of the countries with most cars manufactured since the 1960s, surpassing Germany. The automotive industry in Japan rapidly increased from the 1970s to the 1990s (when it was oriented both for domestic use and worldwide export) and in the 1980s and 1990s, overtook the U.S. as the production leader with up to 13 million cars per year manufactured and significant exports. After massive ramp-up by China in the 2000s and fluctuating U.S. output, Japan is now currently the third largest automotive producer in the world with an annual production of 9.9 million automobiles in 2012. Japanese investments helped grow the auto industry in many countries throughout the last few decades.

The country is home to a number of companies that produce cars, construction vehicles, motorcycles, ATVs, and engines. Japanese automotive manufacturers include Toyota, Honda, Daihatsu, Nissan, Suzuki, Mazda, Mitsubishi, Subaru, Isuzu, Kawasaki, Yamaha, and Mitsuoka.

Cars designed in Japan have won the European Car of the Year, International Car of the Year, and World Car of the Year awards many times.

In the automobile industry, materials used in upholstery, tyres, battery casing, battery acid, padding, insulation, grilles, most interior decor and other components are derived from petrochemicals. Rubber compounds re-enforced with petrochemicals like carbon black and synthetic rubbers are used to manufacture the superior quality vehicle tyres of today. With the existence of a viable petrochemical industry, most of these materials could be made locally, giving added value to the present cars from an assembly plants.

2.1.4 The Building and construction Industry



In the fields of architecture and civil engineering, construction is a process that consists of the building or assembling of infrastructure. Far from being a single activity, large scale construction is a feat of human multitasking. Normally, the job is managed by a project manager, and supervised by a construction manager, design engineer, construction engineer or project architect.

Petrochemical products have wide applications in building and construction.

2.1.4.1 Permanent Fixtures

Permanent fixtures such as floor tiles, electrical insulation, pipes and conduits, ceiling tiles, paints, treated wood, and bathroom fittings such as toilet covers, sinks, and basins are made from petrochemical based materials e.g.

- i. Paint Industries uses resins for making paints
- ii. Treated wood is made of petrochemical resins.
- iii. Bathroom facilities such as toilet covers, sinks, and basins have a good content of petrochemical resins.
- iv. Floor tiles as made from plasticized resins.

2.1.4.2 Household Utensils:

Household utensils such as carpets, chairs, mattresses and pillows, electrical appliances and kitchen wares are made from petrochemical materials. The uses of petrochemicals in building industries are so many that it is very safe to say that no modern building can be completed without petrochemicals in one form or the other.

2.1.5 Health (Pharmaceuticals)



The pharmaceutical industry develops, produces, and markets drugs or pharmaceuticals licensed for use as medications. Pharmaceutical companies are allowed to deal in generic and/or brand medications and medical devices. They are subject to a variety of laws and regulations regarding the patenting, testing and ensuring safety and efficacy and marketing of drugs. The word pharmaceutical comes from the Greek word *pharmakeia*. The modern transliteration of *pharmakeia* is *pharmacia*.

Most pharmaceutical industries are based purely on petrochemical derivatives for the synthesis of drugs. An example is paracetamol. The tablets and capsules when not directly synthesized from one another are bound together with petrochemical products.

Apart from glass which does not react with synthetic drugs, plastics and films from petrochemical products are the only alternatives for the packaging of drugs in the pharmaceutical industry. E.g Disposable syringes are made from plastics.

Plastic Containers:- In medicine, apart from drugs, surgical stitching, surgical dressings and implant materials which are not rejected (react to) by human body are from petrochemical products.

Furthermore, entire disinfectants are manufactured from petrochemicals. Most cosmetics cannot even be started without resorting to petrochemicals either as direct feedstock or the extracting solvent for the active materials. Similarly, it is virtually impossible nowadays to think of modern quality soaps without petrochemicals not to talk of detergents for textiles and domestic hygiene.

This would be very expensive if the country is to depend on the already rising import bill on pharmaceuticals (input for 1979 N200 million) and (2012) the difference is extremely clear. An alternative is the production of some of the pharmaceutical products in the country. This is, however not easy without a petrochemical based industries and a growing challenge to engineers who specialize in power generating sector to put hands on desk and face the challenge.

2.2 Source of Energy

Petroleum products such as petrol, kerosene, gasoline (diesel) etc. are used as fuel in automobile and internal combustion engines. Petroleum fraction, such as kerosene is used as aviation fuel in jet aircraft and is also used domestically as fuel in lighting stoves and lamps. Butane is also used as domestic gas for cookers.

2.3 Petrochemical and Job Creation

Parallel to the stimulation of other industries the widespread application of petrochemicals effectively creates a lot of jobs in some specific industries. The sectors benefiting most for the indirect generation of employment are agriculture, textile, plastic industries, and construction, automobile, health and consumables industries. The international labour organization (ILO) draws the conclusion that the development of petrochemicals leads to a general growth of all the sectors of the economy. Therefore, for Nigeria to achieve the vision 2020:20 it is a must to develop and enhance the petrochemical processing plants and explore more petroleum products especially in the offshore to supplement the existing ones.

2.4 Petrochemical products and there uses.

| Product | End Use (Application) |
|------------------------------------|---|
| 1. Polypropylene (PP) | a. Injection Molded products E.g. Household, waves, Battery cases Fan blades, Syringes etc. b. Crates:- Storage for bottled beverages e.g Soft drink, Beer c. Woven sacks:- Sacks for packaging foodstuff e.g rice, millet, animal feeds, fertilizer etc. |
| 2. Alkyl Benzene (AB) | Detergent (Liquid & powdered) |
| 3. Benzene | Reagent (Solvent) |
| 4. Solvents | Degreasers, metal cleaners, insecticide, odourless paints, dry cleaning agents |
| 5. Heavy Alkylate | Crude oil additives, thermal fluids, transformer oil etc. |
| 6. Sodium Hydroxide (Caustic Soda) | Domestic soap & detergent, enamel ware, bottle washing, glass making, water treatment and vegetable oil refining etc. |
| 7. Polyvinyl chloride (PVC) | a. Extrusive pipes e.g. conduits bottles, wives and cable insulation imitation leather. b. Injection molding footwear, household containers, pipe fittings etc. |
| 8. Low density polythene (LDPE) | a. Extension packaging film e.g. polybags, broad wraps, films for textile, craft wraps etc. b. Non-packaging sheets c. Injection molding: e.g. buckets, plates, cups, pen etc. d. Blow molded products e.g. bottles for drugs and cosmetics, squeezable bottles etc. |
| 9. High Density Polythene (HDPE) | a. Extension E.g. Merchandize bag. b. Infection molded products soft drink crates, household utensils c. Blow molded products e.g. industrial drums, jerry cans and other container |
| 10. Carbon Black (CB) | a. Rubber industry e.g. tyres, foot wears, gaskets etc b. Pigments e.g. paints, ink etc. c. Others:- e.g. carbon papers electrodes |

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